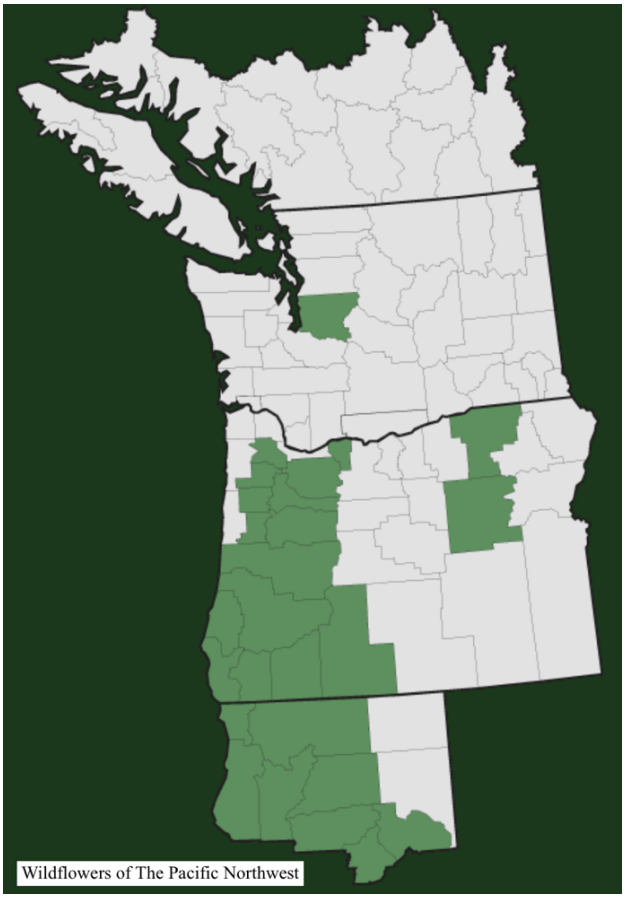
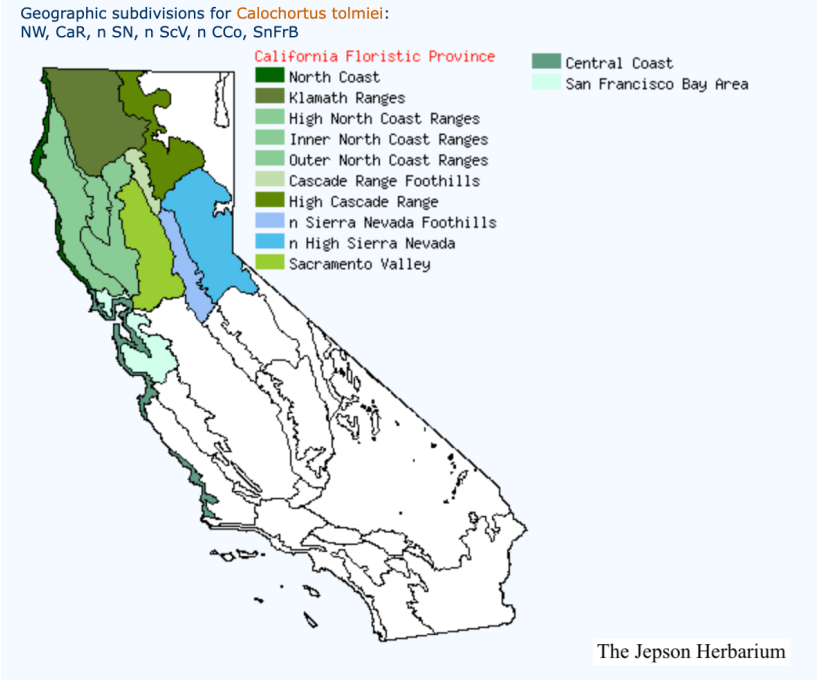
Plant Propagation Protocol for *Calochortus tolemiei*
ESRM 412 – Native Plant Production
URL: https://courses.washington.edu/esrm412/protocols2023/*CATO*.pdf





TAXONOMY	
Plant Family	
Scientific Name	Liliaceae
Common Name	Lily
Species Scientific Name	
Scientific Name	*Calochortus tolmiei* Hook. & Arn.
Varieties	
Sub-species	
Cultivar	
Common Synonym(s)	*Calochortus caeruleus* (Kellogg) S. Watson var. *maweanus* (Leichtlin) Jeps., orth. var. [14] *Calochortus coeruleus* (Kellogg) S. Watson var. *maweanus* (Leichtlin) Jeps.[14] *Calochortus elegans* Pursh var. *lobbii* Baker[14] *Calochortus maweanus* Leichtlin[14]

	Calochortus purdyi Eastw.[14]
Common Name(s)	Tolmie's star tulip[14] Tolmie's pussy ears[5] Hairy star tulip[4] White pussy ears[4]
Species Code (as per USDA Plants database)	CATO
GENERAL INFORMATION	
Geographical range	Western Coast of North America: California (NW, CaR, n SN, n ScV, n CCo, SnFrB)[3], Oregon, Washington[14]
Ecological distribution	Exclusive to the west side of the Cascades from central Puget Sound south to northern California[1]. Lowland valleys to subalpine[11]. Open, dry, grassy slopes, woodland, often in poor soil[3,5], coastal meadow and west-side forest[13].
Climate and elevation range	0-2000m[5] Native to semi-arid climates in western N. America[2]. Very cold hardy but is very intolerant of wetness especially during summer dormancy[2]. plenty of winter moisture but dry summer conditions. USDA Hardiness Zone[4]: 1, 1A, 1B, 4, 5, 6, 7, 15, 16, 17
Local habitat and abundance	Dry, usually rocky, soils sometimes on brushy slopes[11]. Grows best in freely draining soils[2]. Found in scree and coastal meadows at low to moderate elevations, on flats and slopes, in mixed conifer forests and from deep shade to sun[10]. It often occurs in areas with a lot of winter rainfall. In Oregon it occupies several ecosystem types, most commonly in grassy places or steep rocky slopes[1]. Critical bulb in Willamette Valley meadows, especially associated with meadows under Oregon white oaks (*Quercus garreyana)*. Native associates are Pacific blacksnakeroot (*Sanicula crassicaulis),* Henderson's Shooting Star *(Primula hendersonii*), Small flower woodland star (*Lithophragma parviflora)*, Menzies' baby blue eyes (*Nemophila menziesii)*, Oregon iris (*Iris tenax),* and Foothill sedge (*Carex tumulicola)*[1].

Plant strategy type / successional stage	Emerges quickly in early spring, flowers, and goes dormant[1]. Drought tolerant.
Plant characteristics    	Flowering perennial forb[14] from membranous bulb or scaly rhizome[5]. Stem slender, upright, branching 10-120 cm, leaves basal, about same length as stem, persisting through flowering, one smaller leaf on stem[13,14]. Foliage dies back in early summer. Flowers 12–25 mm, on branching stems single to several, erect or spreading; perianth open, campanulate; sepals 10–15mm [13,14]. Petals white to pinkish/purplish to lavender, with deeper lavender staining near base, obovate, adaxial surface densely hairy, margins ciliate, tips with straight hairs on edge. Anthers lanceolate, apex acute to apiculate. Flowering mid spring-midsummer (April-July). Capsules nodding, winged, oblong, 2–3 cm. Seeds deep purple, dark brown in age, irregular[13,14].

PROPAGATION DETAILS

Propagation information is included for *Calochortus* as a genus more generally, as well as specific information about this species.

Ecotype	

Propagation Goal	Plants (ie bulbs)
Propagation Method	Seed + Vegetative
Product Type	Propagules (seeds + bulb)
Stock Type	
Time to Grow	Three to seven years from **seed** to a mature (reproductive) **bulb** (Schmidt). **Seed** grows into **bulb** within two years[3].
Target Specifications	
Propagule Collection Instructions	When grown in cultivation, hand pollination is usually necessary for **seed** production[6]. **Seed** is difficult to collect because the pods hang pendant as the seeds develop and dehisce very quickly, dropping the seeds instantly, making seed collection difficult[10]. One must either collect the pod prematurely or place a paper bag around the pod before the seed is lost.
Propagule Processing/Propagule Characteristics	
Pre-Planting Propagule Treatments	Store **bulbs** in refrigerator until roots appear, at which time they may be planted out for another season[12].
Growing Area Preparation / Annual Practices for Perennial Crops	*Calochortus ssp.* **seed** can be planted in deep pots, flats, or for large quantities, in an outdoor seed bed[12]. Although growing *Calochortus spp.* in pots can be challenging[9]. **Bulbs** are grown in pots, using a friable soil mixture and allowing the pots to dry out after the foliage has died down[12]. *C. tolmiei r*equires a deep, gritty, very well-drained fertile sandy soil in a sunny position[2]. *Calochortus spp.* can be grown in pots or flats with a porous soil mixture using extra measure of sand or vermiculite[14]. In pots, the best mix for growing a number of species of *Calochortus* is the U.C. Davis mix developed for general use, which is recommends to be used with fertilizer[8]. This mix contains 1/2 sand, 1/2 milled sphagnum peat moss. Those in climates with heavier rains (one inch [2.5 cm] or more times a week on average) might prefer a

	lighter mix yet, while those in drier climates might use a more humusy mix, to retain more water. Other mixes include[9]: -2 parts medium fir bark, 2 parts ground forest humus, 1 part sand, and 1 part ground fir bark (developed by Charles Baccus). - 2 parts sand, 1 part topsoil, 1/2 part peat moss, and a handful of ground dolomite (developed by Stan Farwig and Vic Gerard). - 4 parts manureless commercial soil mix (used Supersoil brand potting mix), 1 part peat moss, 1 part vermiculite, 1 part fine sand, and 1 part perlite (developed by Jim Robinett). -U.C. Davis soilless mix: 1/3 perlite, 1/3 vermiculite, and 1/3 sphagnum peat moss. In the ground, the best results for a variety of *Calochortus spp.* were obtained using clay soil, in which many of the spp. grow in the wild[8]. Unless you live in the proper rainfall area, however, it might be better to mix in 50% organic matter to your soil. This can be redwood compost, fir bark, leaf mold or other common soil amendments. Outdoors, star tulips are adaptable and may be used in lightly shaded borders where water is given for most of the year[12]. The star tulips are suitable under trees, among ferns and shade plants, or in raised borders with other diminutive plants. Practically all of the *Calochortus spp.* are drought resistant and should be used in full sun[12]. In moist climates it is usually easier to grow *C. tolmiei* in sun or semi-shade in a bulb frame, though it is worth trying outdoors at the base of a south-facing wall, especially with shrubs that like these conditions[2]. Cold climate growers can simulate native conditions for mild climate species through the use of an unheated greenhouse[8]. Most Pacific Coast species prefer cool, but not frigid winters. In the hilly or mountainous areas where most of

	them grow, they are specialists in surviving where the nights dip below freezing, but the days warm up. An unheated greenhouse can provide warm days, but cool-cold nights. Will not tolerate a heated greenhouse, especially if the greenhouse is kept humid.
Establishment Phase Details	All species of *Calochortus spp.* may be grown from **seed** which is best planted outside in late autumn[12]. Seed of *C. tolmiei* can be sow as soon as it is ripe in the summer or early spring of the next in a cold frame[2]. A cool period may be needed to trigger emergence from summer dormancy, and stratification in a refrigeration by may be helpful especially in regions with mild winters[2,7]. Seed germination occurs at 15°C (60°F)[2]. *Calochortus* species are inclined to germinate at the optimum time of year for rainfall in their indigenous areas and can be difficult to judge when is the optimum planting time is for a species unless one is familiar with the climatic patterns in their indigenous zone[8]. In general, the Pacific Coast species are best planted in late autumn and require a degree of chilling to germinate, and cool conditions for optimum growth. **Seedlings** of all *Calochortus* species should be planted 1/4in-3/4in (0.6 -1.8 cm) below the surface[8]. Seedlings tolerate 1/2-1" (1.2-2.5 cm), but will eventually need more space. Bottom watering **seedling** will reduce the danger of seeds floating or becoming dislodged during the germination period[8]. Top dressing of tiny pebbles or bark pieces on top of the soil or mix to hold the seeds in place during watering, keep the moisture even and insulate against excessive heat or cold. There are some differences in when you should start watering *Calochortus* species depending on

	local climate[9]. Species from areas with mild-winters should be watered starting in the fall, as soon as the weather has cooled, while species from inland cold-climate should be stored dry until mid- to late-winter to mimic being under snow. Some cold-climate *Calochortus* species may also need a period of dry or moist cold storage in mid-winter, to mimic winter conditions before they start to grow in spring.
Length of Establishment Phase	1-6 months[2].
Active Growth Phase	Most *Calochortus* species prefer part shade, especially if the lower part of the plant is in shade and the upper part is in sun[8]. In very hot climates, full shade during the hottest parts of the day may be advisable, with part shade during the early morning and late afternoon. Areas with frequent fog, overcast, clouds or rain may do better with full sun at all times. Keep **seedlings** evenly moist during the period of active growth[12]. The seedlings should be checked every 4-5 days for moisture, especially potted ones[8]. It is advisable to let them dry off a bit between waterings both to discourage damping-off and to increase aeration. Water **bulbs and mature plants** only during their period of active growth[12]. Leave the **seedlings** undisturbed for their first two years of growth but give them an occasional liquid feed to ensure they do not become nutrient deficient[2]. It is quite difficult to get the **seedlings** through their first period of dormancy as they can easy dry out if not watered enough, but will rot if too moist[2]. After their second year of growth, in late summer, transfer dormant **bulbs** into a bigger container and grow for at least another 2 years in the greenhouse before transplanting outside[2].

	Keep eye out for flies, beetles, aphids, mites and thrips[4]. **Watering[8]:** For most *Calochortus spp.* the best watering schedule is once a week, with qualifications for species and local conditions. Any natural precipitation such as a one-day rainstorm counts as a watering. The amount of watering per week when there is no natural precipitation is one inch (2.5 cm), applied at one time but not all at once so seedlings are not deluged all at once. A twice a week schedule is too wet, while twice a month was too little. Species that receive more than one inch per week in the wild, particularly those from No. California and Western Oregon can receive more water, but it should be kept in mind that for the most part these are xerophytic plants, which should be kept on the dry side. Also keep in mind that watering is proportional to drainage; a well-drained mix requires slightly more water than a water retentive mix. Enough water should be applied to keep the water table below the roots, to flush any excess salts (fertilizer) from the root zone and prevent salt build-up. No more than a trickle should appear out of the pot's drain holes after watering. **Nutrients[8]:** The addition of fertilizer is essential if you're using one of the soilless mixes. A complete, low-nitrogen bulb fertilizer (granulated, inorganic bulb fertilizer (about 4-10-10) at one teaspoon per 5 gal. (20 liter) pot, or per square foot of ground) can improve seedling growth, flower quantity and size. Ammonium nitrate, superphosphate, "Miracle-Gro" and dolomitic limestone can also be used. In the trials so far, "Miracle Gro," a commercial fertilizer, proved as effective as the bulb fertilizer. "Natural" materials such as poultry waste can promote rot in potted bulbs. **Pesticides[8]:** Fungicides have been safely tested on seedlings of some *Calochortus* species. A small amount of

	the fungicide specific to the damping-off pathogens may be mixed in the top of the soil to aid in the prevention of damping-off. An alternative is to pasteurize the media by baking it at 180 degrees Fahrenheit (80 °C) for 2 hours.
Length of Active Growth Phase	Fall/early spring – early summer
Hardening Phase	*C. tolmiei* must be kept dry over wintering[2]. Allow *Calochortus* **seedlings** to dry out when yellowing foliage indicates the need for a dormant period, generally by mid- to late summer[12]. Division of the **bulbs** can occur after plants reach flowering[4] as soon as the foliage dies down[2]. Bulbets take two years to reach flowering size[4].
Length of Hardening Phase	Early summer-mid/late summer
Harvesting, Storage and Shipping	If it rains significantly in your area during the dormancy period. **bulbs** should be dug and stored, otherwise they may rot, especially under hot conditions[8]. **Seedlings** should not be uprooted during their first year, thus growers in rainy climates are advised to start their seedlings in pots[8]. By doing so they will be able to avoid having to dig up first year seedlings after dormancy as pots can be dried out without digging or storage. Dry storage can mean very different things, depending on local climate[9]. The soil in the pot needs to be fully dry. In a relatively cool, humid climate, pots may be left in full sun, protected from rain, the ensure soil dries out. In the hot and dry climates with low humidity, pots may be left unwatered in the shade. Many species of *Calochortus* are more vulnerable to summer moisture than bulbs from areas with analogous climates such as South Africa and the Mediterranean, which are better adapted to occasional summer rain. **Bulbs** can be lifted from the group as soon as the foliage dies down in the summer and flowering is

	completed, divided and stored overwinter in a cool dry place, replanting in spring[2]. **Bulbs** are lifted and stored in sealed plastic bags surrounded in peat moss and placed in a refrigerator, or transferred to a new outdoor location[2,7]. The bulbs may be stored in vermiculite or sand to avoid desiccation[8].
Length of Storage	Late summer-spring
Guidelines for Outplanting / Performance on Typical Sites	Plant *Calochortus* spp. **bulbs** about three to four inches deep and closely spaced, from late September through October[12]. Bulbs prefer 3-4" (7.5-10 cm) apart, but will tolerate less if given enough fertilizer[8]. *C. tolmiei* bulbs can be planted end down in 7-10cm (5in) deep and 15 cm (6in) apart.
Other Comments	*Calochortus spp.* often flower well one year and rest for the next year or two before producing blossoms again because the small bulbs may not accumulate enough nourishment to produce flowers every year[12]. *Calochrotus spp* are particular about their requirements and can be challenging to cultivate[12]. Where species in this genus are found is often highly variable, and it difficult to know exactly what each species wants[9]. Growing them in quantity with constant selection of vigorous types will result in a superior strain and more dependable performance[12]. Even if you live in their natural range, they often won't persist more than a year if planted in the ground, unless you prepare the soil properly[9]. Growing techniques need to be adapted to local climate and growing *Calochortus* successfully typically requires experimentation the right combination of soil, sun, and water is determined[9]. Differences in container type, sowing date, growth period and rate of up-potting will vary by plants response to local conditions.
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Protocol Author	Maya Kahn-Abrams
Date Protocol Created or Updated	05/29/23

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